



**University of Dundee**

## **Education for sustainable development amidst COVID-19 pandemic**

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**EDUCATION FOR SUSTAINABLE DEVELOPMENT AMIDST  
COVID-19 PANDEMIC: ROLE OF SUSTAINABILITY  
PEDAGOGIES IN DEVELOPING STUDENTS' SUSTAINABILITY  
CONSCIOUSNESS**

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# EDUCATION FOR SUSTAINABLE DEVELOPMENT AMIDST COVID-19 PANDEMIC: ROLE OF SUSTAINABILITY PEDAGOGIES IN DEVELOPING STUDENTS' SUSTAINABILITY CONSCIOUSNESS

## Abstract

### Purpose

The current study aimed at assessing the impact of Sustainability Pedagogies on students' sustainability consciousness in the online instructional settings during the COVID-19 pandemic.

### Design/methodology/approach

A mixed-method, embedded research design was applied to conduct the research. The participants of the study were the pre-service teachers studying a course namely "Education for Sustainable Development" in a public sector university of Pakistan. A total of 49 participants were divided into control and experimental groups. The experimental group experienced ESD-pedagogies in online teaching-learning (educational) settings whereas the control group was taught through a lecture-based approach in an online educational setting. The outcome of the research was measured in terms of a change in the pre-service teachers' sustainability consciousness. The qualitative data were collected from the experimental group only. The quantitative data were analyzed using paired sample t-test and independent sample t-test whereas the qualitative data were analyzed through thematic analysis.

### Findings

The quantitative and qualitative data indicate that sustainability pedagogies (i.e. case studies, critical incidents, discussions, debates, and problem-based teaching) enhanced pre-service teachers' sustainability consciousness in online educational settings during the COVID-19 pandemic.

**Originality value-** The current research expands the discussion on the effectiveness of sustainability pedagogies in online educational settings in teacher education programs.

**Keywords-** Education for Sustainable Development (ESD), Sustainability Pedagogies, Covid-19, Sustainability Consciousness, Online Instructional Settings

**Paper type-** Quasi-Experimental Research

## 1. Introduction

The COVID-19 pandemic has affected education globally. Educational institutions all over the world were temporarily closed at some point to curtail the spread of this contagious disease into the masses (Singh *et al.*, 2020). As a result, an emergency remote teaching model was adopted for providing uninterrupted learning opportunities to the students (Bozkurt and Sharma, 2020). Despite numerous challenges, educational institutions adopted various online platforms to carry out the educational processes (Flores and Gago, 2020; Iyer *et al.*, 2020; Teräs *et al.*, 2020). Researchers have studied online teaching approaches during the COVID-19 pandemic in various fields such as medical education (Moszkowicz *et al.*, 2020), dental education (Iyer *et al.*, 2020), higher education (Bao, 2020), and teacher education (Flores and Gago, 2020).

Online education has been well-advocated in the field of sustainability education (Azeiteiro *et al.*, 2015; Clark *et al.*, 2016; Diamond and Irwin, 2013) because it can create spaces to mobilize knowledge across countries. It is considered more inclusive since it allows flexibility to attend courses (Azeiteiro *et al.*, 2015). Considering the natural affinity between education for sustainable development (ESD) and online education, it is important to investigate the impact of sustainability pedagogies (in online education) on pre-service teachers' (prospective teachers) sustainability consciousness. Sustainability pedagogies are the pedagogies that are aligned with the spirit of ESD.

The concept of ESD emerged as an educational ideal in 1992 to address the issues of environmental and socio-economic injustice. Since 1992, the concept has been extensively discussed in the literature. According to UNESCO (2014), ESD refers to an educational provision in which "everyone has the opportunity to acquire the knowledge, skills, values, and attitudes that empower them to contribute to sustainable development" (p. 14). In other words, ESD has twofold aims: 1) To include everyone in education, and 2) to organize such learning processes that lead to developing students' awareness of the sustainability issues and help them transform their attitudes and behaviors in the favor of sustainability. Tilbury (2011) has labeled these processes as ESD processes which include: dialogue, collaboration, inclusion, processes of engaging 'whole system'; curriculum and pedagogical innovation; and processes of active and participatory learning (Tilbury, 2011). The pedagogies that have the potential to transform students' sustainability consciousness (a complex of individuals' knowledge, attitude, and behavior towards sustainable development) may be labeled as pedagogical innovations in ESD.

Researchers (Kalsoom and Khanam, 2017; Nousheen *et al.*, 2020) have studied the effectiveness of sustainability pedagogies in transforming pre-service teachers' sustainability consciousness during regular educational setup or pre-Covid time. However, the effectiveness of online, sustainability pedagogies amidst pandemic situations requires exploration. The current study has tried to assess the impact of different transformative, ESD-pedagogical approaches (case studies, critical incidents, group discussions, debates, and problem-based methods), applied during online teaching/learning settings, on pre-service teachers' sustainability consciousness.

## 2. The Study Framework

The study framework has been developed around the constructs of sustainability consciousness, online education, and sustainability pedagogies. The current study is built on an assumption that transformative, constructivist pedagogies in online education may serve as key enablers for promoting sustainability consciousness.

### 2.1 Sustainability Consciousness (SC)

The notion of SC comprises of two complex concepts i.e., sustainability and consciousness. Sustainability refers to sustainable development (SD) i.e., “a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). The UN Agenda 21 provided an action plan for SD that focuses on local, national, and global actions under three dimensions: society, environment, and economy. These three dimensions of sustainability constitute a system through their complex interactions. Sustainability is essentially about sustaining the whole system by maintaining a balance among its components i.e., economy, society, and environment (Kalsoom and Hasan, 2019). UNESCO (2005) mentioned fifteen strategic perspectives in three dimensions of SD. They are; Socio-cultural perspectives (human rights, peace & human security, gender equality, cultural diversity and intercultural understanding, health, HIV/AIDS, and governance); environmental perspectives (natural resources such as water, energy, agriculture, biodiversity, climate change, rural development, sustainable urbanization, disaster prevention, and mitigation); and economic perspectives (poverty reduction, corporate responsibility and accountability, and market economy). UN’s 17 Sustainable Development Goals (SDGs) have also been structured around these three dimensions of SD.

The word ‘consciousness’ is used in everyday language as a synonym for ‘mindfulness’ or ‘awareness’. Oxford dictionary describes ‘consciousness’ in two ways: “the state of being able to use one’s senses and mental powers to understand what is happening”; or “the state of being aware of something” (Oxford, 2015). In scholarly literature, the term ‘consciousness’ appears as a complex construct. Scholars (Chalmers, 1996; Dennett, 1991; Hameroff and Penrose, 2014, Tononi, 2008) from the fields of psychology, philosophy, neuroscience, and quantum physics have explained the concept of ‘consciousness’ very differently. To some ‘consciousness’ is physical while for others it is non-physical. Velmans (2009) views consciousness as a reflexive experience. Conversely, Blackmore and Troscianko (2018) and Noë (2009) use the term ‘consciousness’ more broadly as an equivalent of “subjectivity” or personal experience. This conceptualization resonates with Kollmuss and Agyeman (2002) view of consciousness. To them, consciousness is a complex of knowledge, values, attitudes, and emotions. Based upon this view of consciousness, Kollmuss and Agyeman (2002) have explained the notion of ‘pro-environmental consciousness’. The aforementioned constituents of consciousness are subjective and shaped by personality traits and socio-cultural factors (Kollmuss and Agyeman, 2002).

Building on the concepts of sustainability and consciousness, Gericke *et al.* (2019) describe SC as “the experience or awareness of sustainability phenomena”. Earlier, Olsson *et al.* (2016) and Boeve-de-Pauw *et al.* (2015) explained SC with reference to knowingness (K), attitudes (A), and behavior (B) in the environmental, social, and economic dimensions of sustainable development. Kalsoom and Khanam (2017) defined SC as “awareness of sustainability issues (environmental, social and economic) and knowing about their inter-connectedness along with favorable attitudes and behavior towards addressing these issues” (p. 1094). All these descriptions of SC acknowledge the subjectivity of the construct of consciousness.

## 2.2 Online Education

Online education refers to an education that is delivered using the internet. In online education, teachers develop teaching modules that enhance learning and interactivity in the synchronous or asynchronous environment” (Singh and Thurman, 2019). Although online education has received considerable attention during the Covid-19 pandemic, the use of e-learning or digital technologies in ESD and environmental education have been consistently advocated in the past decade (Azeiteiro *et al.*, 2015; Castle and McGuire, 2010; Chang *et al.*, 2011; Clark *et al.*,

2016; Diamond and Irwin, 2013). Online education may serve as a means of transnational collaboration for sustainability (Caniglia *et al.*, 2018). It can create spaces to mobilize knowledge from local to global scales and across different cultural contexts (Clark *et al.*, 2016). Azeiteiro *et al.* (2015) argue that e-learning programs provide flexibility to the students to pursue their studies flexibly whilst holding down full-time jobs. In other words, online education makes ESD more inclusive by providing an opportunity for more people to be a part of an educational program. In other words, online education is not restricted by time and space. In a recent study, Portuguese Castro and Gomez Zermeno (2020) applied challenge-based learning, in an e-learning context, as a sustainability pedagogy in business education and found the learning outcomes encouraging.

Considering the broader reach of online education, massive open online courses (MOOCs) have emerged as a notable trend in education and ESD as well. MOOCs offer professional development for school leaders, teachers, and policy-makers to enhance their understanding of approaches to transform teacher education towards sustainability. Platforms such as Coursera and EdX deliver MOOC ESD courses (Jobe *et al.*, 2014; Qablan, 2018). Zhan *et al.* (2015) note that although MOOCs ESD is being offered, they mostly adopt a direct instruction approach instead of adopting specific ESD pedagogies.

### 2.3 Sustainability Pedagogies

Sustainability pedagogies refer to the pedagogies that provide sustainability-related experiences to the students. Sterling (2003, 2011) insists that sustainability education is essentially transformative and sustainability pedagogies are those pedagogies that are deeply engaging and have the capacity to transform “deep levels of values and belief through a process of realization and recognition” (Sterling, 2003). With reference to Mezirow’s (1978) theory, transformative pedagogies may be explained as the pedagogies that can bring a change in an individual's frame of reference or meaning perspectives. Frames of references or meaning perspectives refer to a set of assumptions that inform and influence the interpretation of our experiences (Mezirow, 1991). In other words, they give meaning (validation) to our experiences (Taylor, 1998). Affective outcomes (attitudes and behaviors) of ESD require a change in the meaning perspectives and constructivist pedagogies may provide a channel for transforming meaning perspectives by engaging students in transformative learning experiences. Kalsoom (2019) argued that constructivist pedagogies that focus on sustainability issues provide a context to transform learners’ attitudes. Scholars (Brundiers *et al.*, 2010; Lasen *et al.*, 2015; Wiek *et al.*, 2014) have labeled constructivist pedagogies as transformative pedagogies.

Researchers have studied and discussed various pedagogical approaches as transformative pedagogies to teach sustainability-related concepts (Cotton and Winter, 2010; Dziubaniuk and Nyholm, 2020; Lozano *et al.*, 2017; Seatter and Ceulemans, 2017). Cotton and Winter (2010) and Segalàs *et al.* (2010) suggested many pedagogical approaches to teach sustainability-related concepts. Some of them include role-plays and simulations, group discussions, debates, critical incidents, case studies, critical reading and writing, problem-based learning, fieldwork, and modeling good practices. Similarly, Lozano *et al.* (2017) proposed twelve pedagogical approaches to teach sustainability-related concepts/courses. These pedagogical approaches include case studies, interdisciplinary team teaching, lecturing, mind and concept maps, problem-based learning, community service learning, jigsaw/interlined team, participatory action research, eco-justice and community, place-based environmental education, supply chain/life-cycle analysis, and traditional ecological knowledge. Lozano *et al.* (2017) divide these pedagogical approaches into three groups i.e., universal, community and social justice, and environmental education. Although these

pedagogical approaches have been suggested by various researchers, effective implementation of these pedagogical approaches requires significant time, preparation, and resources (Cotton and Winter, 2010). Due to the limitation of time and resources, the current study utilized five pedagogical approaches i.e., case studies, critical incidents, debates, group discussions, and problem-based learning.

### 3. The Study Context

The catastrophic situation of Covid-19 pushed educational institutions across the world to move from face-to-face classes to online classes. Given this, the University of Education, one of the largest universities in Pakistan, also started online classes. The University of Education has been offering a mandatory course namely “Education for sustainable development” in the Master in Education program since 2007. The course has two purposes: 1) to make the pre-service teachers sustainably conscious; 2) to develop pre-service teachers’ capacities as ESD pedagogues so that they can implement ESD in their classrooms.

In the face of a lockdown situation, the University of Education started online classes. The subject teacher was responsible to upload recorded lectures on the Google Classroom and interact with the pre-service teachers virtually via Zoom or Google Meet. The researcher (the first author) teaches the course on ESD. She employed five ESD-pedagogies (case studies, critical incidents, group discussions, debates, and problem-based methods) online and studied their impact on pre-service teachers’ SC.

### 4. Methodology

#### 4.1 Research design

The current research utilized a mix-method, embedded research design. This design involves at least one quantitative and qualitative strand, however; the qualitative techniques hold a secondary role (Green *et al.*, 2007; Huang, 2015). The quantitative strand was guided by the quasi-experimental, pre-and post-intervention design. The first author implemented the intervention and collected the data while teaching the course “Education for sustainable development”.

Students were divided into two groups using the random sampling technique. First of all, a list of all the 49 pre-service teachers was prepared. In the next step, each student was assigned a sequential number. A random number generator was used to prepare a random number table. By using these steps, 25 students were selected for the experimental group and the remaining students were included in the control group. During the qualitative strand of this design, twelve pre-service teachers were selected for one-to-one semi-structured interviews.

#### 4.2 The Participants

Forty-nine pre-service teachers (40 females and 9 males) enrolled in the second semester of a Master in Education program participated in the current study. In Pakistan, teacher preparation programs are largely attended by female pre-service teachers (Kalsoom *et al.* 2017; Nousheen *et al.*, 2018). This uneven ratio of pre-service teachers reflects in the current study’s sample as well. The sample size was well above the minimum required number of subjects in an experimental study. According to Cohen *et al.* (2002), there should be at least 15 participants in the study whereas Gall *et al.* (1996) suggested including at least 15 participants in the control and 15 in the experimental group. The participants’ ages ranged from 21 to 30 years. None of the participants had ever studied any course or attended seminars related to sustainable development.

#### 4.3 Instrumentation

There is a growing interest in measuring students' knowledge, attitude, and behavior towards sustainable development (Kalsoom *et al.*, 2017). Michalos *et al.* (2012) developed a 50-item scale to measure grade-10 students' knowledge, attitude, and behavior towards SD in the Canadian context. Later, Swedish and Pakistani researchers (Berglund *et al.*, 2014; Olsson *et al.*, 2016; Olsson and Gericke, 2016) adapted Michalos *et al.*'s tool to assess students' SC. The current research also used Michalos *et al.* (2015) scale after seeking permission from the researchers. The 50-item questionnaire consists of three sections: 1) knowledge index consisting of 20 items; 2) attitude index consisting of 15 items, and 3) behavior index consisting of 15 items. Each item is measured on five points Likert scale ranging from 1 to 5 where 1 = strongly disagree and 5 = strongly agree.

The other instrument used in the current study was a semi-structured interview. Pre-service teachers were requested to participate in the interview after undergoing sustainability pedagogies intervention. The average time for each interview was 18 minutes. The interview protocol included five questions adapted from Evans *et al.* (2016) and Kalsoom (2017).

1. Which aspects of the sustainability pedagogies do you appreciate the most?
2. How would you rank the ESD-pedagogical approaches (case studies, problem-based learning, critical incidents, and debates) with reference to their effectiveness in enhancing SC?
3. How would you describe the impact of ESD-pedagogical approaches on your knowledge about SD/ sustainability?
4. Do you think that ESD-pedagogical approaches in online settings affected your attitude toward SD? If yes, how?
5. Do you think that ESD- pedagogical approaches in online settings affected your sustainability-related behavior? If yes, how?

#### 4.4 *Framework for the Data Analysis*

The data obtained from the pre-and post-intervention survey was statistically analyzed. To identify any difference in the SC level of both the groups, their scores on the pre and post-intervention survey were compared through an independent sample t-test. To assess any change in the SC of the experimental group before and after the sustainability pedagogies intervention, the mean SC scores before and after the interventions were compared through a paired sample t-test. A specific code was assigned to each response to apply paired sample t-test.

The interview data were interpreted through the data analysis process suggested by Miles and Huberman (1994). The process consists of three steps: data reduction, data display, and conclusion drawing/verification (Miles and Huberman, 1994). Initially, each interview was individually examined and labeled/coded. Once all the transcripts were carefully examined, common themes were identified across all the transcripts and displayed in a table under a more specific category. The data was arranged according to the themes and checked against the initial codes to confirm their validity.

#### 4.5 *Ethical consideration*

The current study was undertaken after the formal approval of the campus Head. Participation in the current study was voluntary and anonymous.

#### 4.6 *Limitation*

The data has come from only one cohort of 49 pre-service teachers studying in a public sector university in Pakistan. Pre-service teacher

#### 4.7 *Study Procedure*



1. After the formulation of experimental and control groups, two separate Google Classrooms were formed for both groups, and an invitation was forwarded to the pre-service teachers to join their respective classrooms.
2. A link to the questionnaire (aimed at measuring SC before the intervention) was shared via Google Classrooms. The participants were requested to fill out the questionnaire. The data was automatically saved to Google Sheets for later use.
3. The purpose of the study was shared with the students. The course on ESD was taught to both the groups i.e., experimental and control. Both groups experienced learning through recorded online lectures, videos on sustainability issues, quizzes, assignments, and online presentations. In addition to the aforementioned activities, the experimental group experienced the intervention of ESD-pedagogical approaches (case studies, critical incidents, debates, group discussion, and problem-based) as proposed by Cotton and Winter (2010). The details of the course contents and pedagogical approaches used for teaching both control and experimental groups are outlined in Table I.
4. The intervention of ESD-pedagogical approaches (case studies, critical incidents, debates, group discussion, and problem-based) was implemented with the experimental group.
5. Both the groups participated in the study for 16 weeks, from March-June 2020.
6. The post-intervention survey was conducted in the thirteenth week of the course.

*Insert Table I Here*

## 5. The Findings

Before any intervention, both the experimental and control groups were required to fill the SC questionnaire. The collected data was then checked for assumptions of the independent sample t-test. The data collected met all the six assumptions of the independent sample t-test. There was no outlier, scores were normally distributed, as assessed by Shapiro-Wilk's test ( $p > 0.05$ ), and there was homogeneity of variances, as assessed by Levene's test for equality of variances ( $p > 0.05$ ). Hence, the t-test was applied to the data. The results of the independent sample t-test in Table II indicate that both the control and experimental groups had the same level of SC before the implementation of the study intervention.

To determine the effectiveness of ESD-pedagogical approaches on pre-service teachers' SC, the post-intervention scores of the control and experimental groups were compared through the independent sample t-test. The results (Table II) show that pre-service teachers who underwent ESD-pedagogical treatment had a higher mean score (on the SC-scale) as compared to their counterparts (control group) i.e.,  $t(47) = 6.6510$ ,  $p < 0.05$ .

*Insert Table II Here*

Table III indicates the group comparison of pre- and post-intervention SC of pre-service teachers in the experimental group. The results of the paired sample t-test (Table III) indicate that there is a significant difference between the mean scores (on the SC-scale) before and after the implementation of sustainability pedagogical intervention i.e.,  $t(24) = -9.602$ ,  $p < 0.05$ . In other words, the results indicate that the experimental group reported an increase in their mean

1  
2  
3 score (on the sustainability scale) after experiencing the sustainability pedagogical  
4 intervention.  
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8 *Insert Table III Here*  
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11 An analysis (through a paired sample t-test) of the pre-service teachers' scores on the  
12 three dimensions of the SC survey (knowledge, attitude, and behavior) before and after  
13 studying the ESD course was also carried out. The results in Table IV indicate that the  
14 sustainability-related course contents transformed pre-service teachers' knowledge and attitude  
15 in both groups. However, the pre-service teachers (in the control group) reported an  
16 insignificant change in their behavior towards sustainable development. On the other hand, the  
17 experimental group showed an improvement on all three indices of the SC.  
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21 *Insert Table IV Here*  
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24 The summary of the results from the qualitative data is provided in Table V. As a part of the  
25 interview, pre-service teachers were requested to rank the various pedagogical approaches used  
26 during the course. The pre-service teachers ranked the five pedagogical approaches based on  
27 their perception of the effectiveness of these pedagogical approaches in enhancing their SC.  
28 Score five depicted a highly effective pedagogical approach and score one represent the least  
29 effective pedagogical approach in enhancing SC. Once each pre-service teacher ranked all the  
30 pedagogical approaches, the scores of all the respondents were added to get a cumulative score.  
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### 33 **5.1 Aspects of ESD Pedagogies Students Appreciated the Most**

34 The analysis of the interview responses resulted in three basic categories: the teaching style  
35 and methods, organization and appropriateness of the course content, and engaging activities.  
36 The respondents appreciated the teaching styles and methods the most followed by engaging  
37 activities, appropriateness of the course, and content organization. Although most of the pre-  
38 service teachers appreciated teaching styles and methods, one student specifically stated that  
39 the teacher's teaching style and methods (applied during the course) made a real difference.  
40 Another student stated that the course content was well organized, and the teaching style  
41 stimulated their interest and understanding in the course. While talking about the course, a  
42 student stated that the course content was in accordance with the goals and objectives provided  
43 in the course outline. Moreover, the course contents were recent, relevant, and appealing. While  
44 talking about the activities during the course, a student stated that the activities utilized by the  
45 teacher during the course were engaging, carefully constructed, and offered an opportunity to  
46 the pre-service teachers to express themselves freely and to clarify their misconceptions.  
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52 *Insert Table V Here*  
53

### 54 **5.2 Increased Knowledge about Sustainability**

55 All twelve participants in the interview maintained that their knowledge of sustainability issues  
56 increased after participating in different ESD-related activities. One participant mentioned:  
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58  
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*The concept of SD was new to us, at least to me. The teaching strategies utilized over the course were properly designed and effectively implemented. The activities introduced us to a range of knowledge [information] that would not be possible from the lecture method only.*

The following responses also indicate that the activities (based upon ESD-pedagogical approaches) were helpful in increasing pre-service teachers' knowledge of sustainability issues.

*I am aware of the sustainability problem now.*

*The course was full of useful activities. Sometimes the syllabus seemed overwhelming, but in the end, the course provided us with very useful knowledge and pedagogical experiences.*

*The course content and pedagogies introduced us to global issues.*

*At the start of the semester, everyone thought this course was related to environmental education. However, after a few classes, we understand this is much more than that.*

### **5.3 Changes in Attitude towards Sustainability**

All the respondents mentioned that the course activities have positively influenced their attitude. Now they are more concerned about the issues related to the environment and socio-economic justice. They have started thinking about various initiatives for poverty, environment, and waste management, etc., at individual levels. Here are some of the responses from the study participants.

*The case study on water scarcity in Pakistan literally shocked me. I realized how much water we are wasting at the individual level every day.*

*Through this course, I have learned about how to live as a responsible citizen for a more sustainable future. I have explored different problems and issues related to SD through class discussions, case studies, debates, and problem-based learning.*

*The course and the pedagogical techniques helped us to reflect on our own lives and society to achieve personal as well as societal sustainability.*

*My attitude towards sustainable development has surely changed. Initially, I never thought about it like the way I think now.*

*The course through innovative and multi-method teaching techniques gives us a fair idea of these issues and their criticality. In this course, I felt a change in myself. I admit, my thinking and actions have been more conscious than before.*

*In my opinion, sustainability needs a permanent change in the individual conscience and this course affected our conscience, at least to some extent.*

### **5.4 Changes in Behaviour towards Sustainability**

Most of the respondents maintained that the course content and the activities brought a change in their behavior towards sustainability. One participant said:

*This subject [course] was one of my favorites due to its practical implication in our daily lives. It brought a significant change in my thinking and actions. We were involved in activities like discussions, case studies, debates, and problem-based learning. These activities have impacted my personal actions.*

Other participants also mentioned the adoption of different sustainable behavior ranging from avoiding food wastage to reduce water consumption; from walking to the use of public

transport; use of sunlight for heating to electricity through solar energy; and reducing purchasing of new products to the purchase of bio-friendly products. Here are some of the responses from the study participants.

*The course and the pedagogical approaches offered us an opportunity to assess our lifestyle and I realized that we have an extremely unsustainable lifestyle. As a first step, I am trying to avoid food wastage using simple methods like less buying less wasting, storing/freezing extra food. This behavior not only has financial benefits for us but also develops a sense of contribution towards a better future.*

*I have started to use public transport as it is inexpensive, reduces carbon emission, improves mobility, and offers economic benefits to the community.*

*We have installed solar panels at our home which not only contribute to less greenhouse gas but also provide us ongoing free energy and independence of load shedding.*

The above comments indicate that ESD-pedagogies along with the sustainability curriculum have a significant impact on the pre-service teachers' SC even during the COVID-19 pandemic in online learning settings.

### 5.5 Comparison of ESD-Pedagogical Approaches

The data indicate that the pedagogies were ranked in the following order by the preservice teachers: discussions, case studies, problem-based learning, critical incidents, debates. Group discussion was ranked highest (a score of 52) among all pedagogical approaches.

In addition to ranking, the participants commented on the pedagogies which they had experienced. Some of the comments are:

*The case study approach was a very useful technique as it provides a wide array of information and knowledge regarding sustainability issues from various stakeholders' perspectives.*

However, another student found case studies challenging and uncomfortable. She said:

*Some students become anxious as a case study requires students to study issues from various perspectives and there is no single solution.*

## 6. Discussion

The effectiveness of different constructivist pedagogies as ESD-pedagogies has been well-researched in face-to-face classes (Cheong, 2005; Kalsoom and Qureshi, 2021). The current study contributes to the literature on the effectiveness of these pedagogies in online settings. In online education, teachers develop teaching modules that enhance learning and interactivity in the synchronous or asynchronous environment" (Singh and Thurman, 2019). Before discussing the results of the current study, the researchers want to establish that the study findings have come only from one cohort of students who studied the course of ESD during lockdown for Covid-19. Despite limitations, the current study offers an insight into the effectiveness of ESD-pedagogical approaches in online instructional settings.

The results of both the qualitative and quantitative data indicate that ESD- pedagogical approaches have a significant and positive impact on pre-service teachers' SC. Upon looking into the dimensions of SC, it was interesting to find that the participants of the control group reported an increase in their knowledge and attitude (see Table IV); however, no change was found in their behavior. On the other hand, the pre-service teachers of the experimental group depicted an increase in all three dimensions of SC. These results are in line with the previous

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3 studies (Kalsoom and Khanam, 2017; Michalos *et al.*, 2012). Kalsoom and Khanam (2017)  
4 used an inquiry-based pedagogical approach to teach sustainability-related concepts and found  
5 that pre-service teachers scored higher on the knowledge index of the SC scale and lowest on  
6 the behavior index. Moreover, Michalos *et al.* (2012) also found similar results (maximum  
7 mean score on knowledge index) while assessing the knowledge, attitude, and behavior of  
8 participants who experience ESD concepts in 10<sup>th</sup> grade. Kalsoom and Khanam (2017) argued  
9 that transformation in attitude and behavior is affective learning and requires a change in  
10 peoples' frame of reference. It is relatively hard to achieve as compared to acquiring new  
11 knowledge about something. The current study also supports this argument. The study findings  
12 further highlight the importance of a standalone ESD course on one hand and the key role of  
13 transformative pedagogies on the other hand. The study results show that after studying the  
14 ESD course, the mean score of both the control and experimental groups on the SC-scale  
15 increased. This indicates that a carefully planned standalone course on ESD provides an  
16 opportunity for pre-service teachers to become aware of economic, social, and environmental  
17 issues.  
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21 Although Pre-service teachers of both groups studied the same course content, the  
22 higher mean score of the experimental group can be associated with the sustainability  
23 pedagogical intervention used by the researcher (the first author of the paper). The control  
24 group underwent traditional teaching (online lecturing and presentations). The study findings  
25 support the existing literature (Nousheen *et al.*, 2020; Seatter and Ceulemans, 2017) that  
26 suggests the use of constructivist, active, and student-centered pedagogical approaches in ESD.  
27 The findings of the current research affirm that constructivist pedagogies are useful in online  
28 educational settings as well.  
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31 The finding that the participants ranked group discussion as the most useful pedagogy  
32 in enhancing sustainability consciousness resonates with the findings of Kalsoom and Khanam  
33 (2017). They had found that discussion (during sustainability-focused research) contributes  
34 towards enhancing the SC of the pre-service teachers. However, the reason behind the  
35 choice/ranking of the pedagogical approaches in the study participants is unclear and requires  
36 further investigation. Although all these approaches have been frequently used to teach  
37 sustainability-related concepts, it is too early to conclude the best choice for teaching  
38 sustainability-related concepts. The current study did not compare the effectiveness of various  
39 techniques. However, the findings of qualitative and quantitative data indicate the effectiveness  
40 of multi- sustainability pedagogies in enhancing pre-service teachers' SC in online educational  
41 settings.  
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## 44 **7. Conclusion**

45 The study complements the previous studies which show that constructivist, student-centered,  
46 transformative pedagogies improve students' knowledge of sustainability issues and transform  
47 their attitude and behaviors in the favor of sustainability. The current study supports the claim  
48 that ESD is transformative education and requires transformational/sustainability pedagogies.  
49 The transformative characteristics of the ESD demand transformative pedagogies (i.e.,  
50 sustainability pedagogies). The results of the current research suggest that sustainability  
51 pedagogies work in online educational settings as well. The current study does not make any  
52 claims about the superiority of one pedagogical approach over others rather suggests the use  
53 of multi sustainability pedagogies in online teaching contexts. Although the current study  
54 reports a change in the pre-service teachers' SC after participating in an ESD course that was  
55 taught through ESD pedagogies, no claim could be made regarding the long-term impact of the  
56 intervention on the participants' SC.  
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3 The study findings have implications for teacher education programs. The findings  
4 suggest that a course on ESD should be a part of teacher education programs as it helps enhance  
5 the participants' SC. The study also suggests further research related to SC and sustainability  
6 pedagogies. Researchers may also study what makes the discussion method more effective  
7 (with preservice teachers) as compared to other constructivist pedagogies. Future research may  
8 increase the scope of the research by studying a larger sample.  
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10 The current study has certain limitations. Pre-service teachers were not familiar with  
11 the use of online forums at the time of the current study. Moreover, there were issues pertinent  
12 to connectivity i.e., lack of infrastructure and internet speed. Another limitation was the small  
13 sample size. Only limited students were available for the current study as the course on ESD is  
14 offered once a year in a few universities of Pakistan.  
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Table I: Examples of pedagogical approaches used in the control and experimental groups

Course Content	Pedagogies Employed in Both Groups	Additional Pedagogies Employed in the Experimental Group
<b>Sustainable Development and Sustainable development Goals (SDGs)</b>	Both the groups were given a brief introduction related to the concepts, background, and history of SD. Various SDGs related resources published by United Nations and Federal SDGs Support Unit, Pakistan were uploaded in the Google Classroom	The experimental group was directed to discuss the federal and provincial governments' engagement with ESD. The participants were divided into small groups (five members in each group) and were asked to discuss the current situation of SDGs in Pakistan with reference to political commitment.
<b>Areas of SD</b>	Lectures on the concepts related to environmental degradation, climate changes, water, land, energy resources, and global warming.	<b>Case study and Discussion:</b> The participants were provided with the case study of the controversial Kalabagh Dam (Pakistan). They worked in small groups and discussed the case in the light of the following questions: i) Are the issues discussed in the case study real or political? Was it a real threat? Should it be built or not? If yes why, and if not, why not? How the issue could have been resolved politically in a better way?
<b>Major SD problems in Pakistan as a developing country</b>	<ul style="list-style-type: none"> <li>• Recorded and uploaded (in Google Classroom) the lectures regarding environmental pollution, social security, depletion of natural resources, inequality, education, and poverty in Pakistan.</li> <li>• The Head of an NGO working for poverty alleviation and accessible education for all in Pakistan was invited to speak on the issues of poverty and education for all.</li> </ul>	<b>Critical incidents:</b> The participants were asked to identify unsustainable practices in their daily routine and surroundings, and share them in the class. Once critical incidents were identified and scenarios were built, the participants were asked to think about the answers to the following questions. i) What would they do? ii) What they could do? and iii) what they should do?
<b>SD at global and local scenario</b>	Students were given a detailed overview of the status of SD in various developed, developing, and underdeveloped countries.	<b>Group Discussion.</b> The participants were required to read about the pro-sustainability initiatives taken by various countries and discuss them with reference to the implementation process,

Course Content	Pedagogies Employed in Both Groups	Additional Pedagogies Employed in the Experimental Group
		<p>challenges, stakeholders' involvement, and the cultural acceptance for SD.</p> <p><b>Debate.</b> The debate was held on the following topics.</p> <ol style="list-style-type: none"> <li>1) Our lifestyle and sustainability</li> <li>2) Urbanization and agriculture</li> <li>3) Water resources, scarcity, and consumption.</li> <li>4) Do you agree with the prioritization of SDGs by the Ministry of Planning Development and Special Initiatives? Why?</li> <li>5) Culture and sustainability</li> </ol> <p>Three senior faculty members were invited to attend the session and provide feedback to the participants.</p>
<p><b>The solution to SD problems</b></p>	<p>The teacher provided an overview of the sustainability problems around the world and global initiatives (such as the Decade of Education for Sustainable Development and SDGs) to combat unsustainability.</p>	<p>The participants were asked to select a sustainability-related problem in the Pakistani context and conduct small-scale research to understand the problem under investigation. The participants conducted a literature review around the selected problem, collected and interpreted data, and shared their findings with the whole class.</p>

*Table II: SC of the Control and Experimental Group*

<b>SC</b>	<b>Groups</b>	<b>N</b>	<b>M</b>	<b>SD</b>	<b>df</b>	<b>t</b>	<b>Sig</b>
Pre	Control	24	3.1554	0.3997	47	0.5469	0.612
	Experimental	25	3.2047	0.3344			
Post	Control	24	3.6411	0.2453	47	6.6510	0.000
	Experimental	25	4.0703	0.2012			

Table III: Experimental Group Pre- and Post-scores on the SC Scale

Experimental Group	Mean	SD	t	df	Sig
Pre-test	3.2047				
Post-test	4.0603	0.44553	-9.602	24	0.000

Table IV: Impact of ESD-Course on Preservice Teachers' Knowledge, Attitudes and Behaviors towards Sustainability

Groups	Dimension	Test (Pre/ Post)	Mean	SD	t	df	Sig
Control	Knowledge	Pre	3.0850	0.8412	4.256	23	0.000
		Post	3.8211				
	Attitude	Pre	3.2876	0.7184	-2.326	23	0.034
		Post	3.6928				
	Behaviour	Pre	3.2180	0.8586	-0.548	23	0.591
		Post	3.3322				
Experimental	Knowledge	Pre	3.1817	0.7646	-6.430	24	0.000
		Post	4.1650				
	Attitude	Pre	3.2533	0.6238	-6.590	24	0.000
		Post	4.0755				
	Behaviour	Pre	3.1859	0.6948	5.452	24	0.000
		Post	3.9435				

Table V: Summary of the interview analysis

Questions	Responses Coded	Selected Responses	Number of Response OR Cumulative Score
Which aspects of the sustainability pedagogies do you appreciate the most?	Teaching styles and Methods	I liked teacher style to explain the course concept, flexibility in teaching, facilitating student learning, utilization of various methods during this course.	11
	Appropriateness of course content	The course contents were according to the needs of the students and the current era [global needs].	08
	Classroom activities	The classroom activities offered a diverse array of knowledge to the students, promoted collaboration, and offered experiential learning.	10
How would you rank the ESD-pedagogical approaches (case studies, problem-based learning, critical incidents, and debates) with reference to their effectiveness in enhancing SC?	Group Discussion	Group discussions provided us with the opportunity to see various sustainability related-issues from various perspectives and share our point of view.	52
	Case studies	Case studies helped us to see problems from multi-stakeholders' lenses.	42
	Problem-based learning	Problem-based learning helped us grow our awareness regarding the local issues critically.	39
	Critical Incident	The practice of identifying various critical incidents was productive and a good experience. It will help us in our future teaching.	33
	Debates	Preparation for debates not only enhances our knowledge but also our communication skills.	25
How would you describe the impact of ESD-pedagogical approaches on your knowledge about SD/ sustainability?			Yes = 11 No = 0
Do you think that ESD-pedagogical approaches in online settings affected your attitude toward SD? If yes, how?			Yes = 11 No = 0
Do you think that ESD- pedagogical approaches in online settings affected your sustainability-related behaviour? If yes, how?			Yes = 11 No = 0